

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 06-153546

(43)Date of publication of application : 31.05.1994

(51)Int.Cl.

H02N 2/00

(21)Application number : 04-322450

(71)Applicant : OLYMPUS OPTICAL CO LTD

(22)Date of filing : 06.11.1992

(72)Inventor : FUJIMURA TAKENAO
FUNAKUBO TOMOKI
IMABAYASHI HIROYUKI

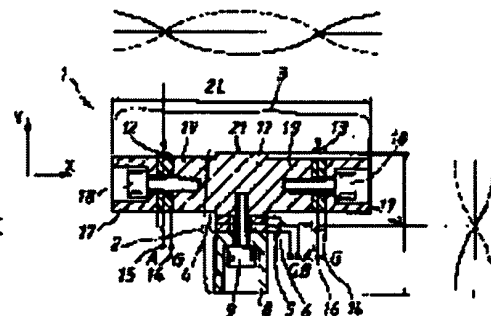
(54) ULTRASONIC OSCILLATOR AND ULTRASONIC ACTUATOR

(57)Abstract:

PURPOSE: To obtain an ultrasonic oscillator and an ultrasonic actuator in which the longitudinal oscillation of the ultrasonic oscillator is synthesized and a large reversible elliptical oscillation is excited and a driving can be efficiently performed.

CONSTITUTION: An ultrasonic oscillator 1 comprises a first oscillator 2 and a second oscillator 3, and a first piezoelectric element 4 is placed in a node position of a longitudinal resonance of the first oscillator 2. The first piezoelectric element 4 is fixed on a resonator together with a resonator 8.

Piezoelectric elements 12 and 13 and a resonator 17 are fixed on a protrusion 19 of the resonator.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

*** NOTICES ***

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the ultrasonic vibrator made to generate supersonic vibration by electric-mechanical energy sensing elements, such as a piezoelectric device and an electrostriction component.

[0002]

[Description of the Prior Art] An ultrasonic vibrator has from before the ultrasonic vibrator of a configuration which the object which carried out various configurations is proposed, for example, was indicated by JP,59-37673,B. As the above-mentioned invention is shown in drawing 17 , the langevin type oscillator 92 which carried out the same configuration, respectively is being fixed to the third page of the left and right laterals of the oscillating object 91, and an inferior surface of tongue, and the oscillating piece 93 which had an inclination in the top face of the oscillating object 91 is formed.

[0003]

[Problem(s) to be Solved by the Invention] However, in an ultrasonic vibrator given [said] in JP,59-37673,B, it is the configuration which fixed three langevin type oscillators 92 of the same configuration to the third page, and is going to excite ellipse vibration using vertical resonance of each langevin type oscillator 92. However, in the phase which fixed the langevin type oscillator 92 to the oscillating object 91, since resonance frequency is decided by the die length of the langevin type oscillator 92 fixed whole, in the direction of a in drawing 17 , and the direction of b, the resonance frequency of longitudinal oscillation produces a gap in resonance frequency, and cannot excite ellipse vibration at the root of the oscillating piece 93 in fact. For this reason, by leaning the oscillating piece 93, it comes and pokes and has become a lifting and the ultrasonic vibrator which causes vibration of only an one direction about movement.

[0004] Therefore, this invention was developed in view of the fault in said conventional technique, and it is small, and its output is large and it aims at offer of the ultrasonic vibrator which can excite an reversible ellipse vibration, and an ultrasonic actuator.

[0005]

[Means for Solving the Problem] The ultrasonic vibrator of this invention combines two or more langevin type oscillators with a right angle respectively in the antinode location of longitudinal oscillation, it is the ultrasonic vibrator made to generate ellipse vibration, and the ratio of the die length of each langevin type oscillator becomes an abbreviation integer.

[0006] In the antinode location of the first vibrator which consists of a resonator arranged on two or more piezoelectric devices allotted to the knot location of longitudinal oscillation, and its both sides, and the first vibrator, moreover, by the first vibrator, right angle, and bilateral symmetry Have said vibrator twice the die length of the first, and it has two or more piezoelectric devices in two or more knot locations of longitudinal oscillation, respectively. It consists of the second vibrator which consists of a resonator inserted into this piezoelectric device, and a resonator arranged on the both sides of this piezoelectric device. The phase of the high-frequency voltage impressed to the piezoelectric device allotted to ***** of said second vibrator is shifted 180 degrees. A phase is shifted so much 90 degrees to the high-frequency voltage impressed to the piezoelectric device allotted to the second vibrator in the phase of the high-frequency voltage impressed to the piezoelectric device allotted to said first vibrator.

[0007] In the both-ends antinode location of the first vibrator which consists of a resonator arranged on two or more piezoelectric devices allotted to the knot location of a primary longitudinal oscillation, and its both sides,

and the first vibrator, furthermore, by the first vibrator, right angle, and bilateral symmetry Have said vibrator twice the die length of the first, and it has two or more piezoelectric devices in two or more knot locations of longitudinal oscillation, respectively. It consists of the second vibrator of a pair which consists of a resonator inserted into this piezoelectric device, and a resonator arranged on the both sides of this piezoelectric device. The phase of the high-frequency voltage impressed to the piezoelectric device allotted to ***** of said second vibrator is shifted 180 degrees. A phase is shifted so much 90 degrees to the high-frequency voltage impressed to the piezoelectric device allotted to the second vibrator in the phase of the high-frequency voltage impressed to the piezoelectric device allotted to said first vibrator.

[0008] To the both-ends antinode location of the first vibrator which consists of a resonator arranged on two or more piezoelectric devices allotted to the knot location of a primary longitudinal oscillation, and its both sides, and the first vibrator, to a radial moreover, by the first vibrator, right angle, and bilateral symmetry Have said vibrator twice the die length of the first, and it has two or more piezoelectric devices in two or more knot locations of longitudinal oscillation, respectively. It consists of two or more second vibrator which consists of a resonator inserted into this piezoelectric device, and a resonator arranged on the both sides of this piezoelectric device. The phase of the high-frequency voltage impressed to the piezoelectric device allotted to ***** of said second vibrator is shifted 180 degrees. A phase is shifted so much 90 degrees to the high-frequency voltage impressed to the piezoelectric device allotted to the second vibrator in the phase of the high-frequency voltage impressed to the piezoelectric device allotted to said first vibrator.

[0009] Furthermore, the second vibrator of the same configuration as the first vibrator is arranged [the main antinode location of the first vibrator which consists of a resonator which put two or more piezoelectric devices between two or more knots, and the first vibrator] by the right angle to the first vibrator at the symmetry, respectively.

[0010] Moreover, an amplitude expansion device is allotted to a resonator and one in an ellipse oscillating generating side.

[0011] Furthermore, while an ultrasonic vibrator is fixed near the knot location of the first vibrator by the conclusion member by which the end was fixed to the fixed end, except the conclusion section, the crevice for not contacting said conclusion member is formed in the resonator.

[0012] Moreover, a vibration isolation device is prepared in a conclusion part with the fixed end of a conclusion member.

[0013] The ultrasonic actuator of this invention consists of the ultrasonic vibrator which fixed the slide member to the ellipse oscillating generating section of the above-mentioned ultrasonic vibrator, a driven member driven by ellipse vibration through said slide member, a press device, and the guide section.

[0014]

[Function] In this invention, by having made into the integral multiple the ratio of the die length of the langevin type oscillator arranged in all directions, it becomes possible to make in agreement the resonance frequency of the longitudinal oscillation of two directions, and improvement in effectiveness can be aimed at by having allotted the piezoelectric device to the knot location, respectively. Moreover, the amplitude of the second vibrator increases by having made the second vibrator into the two times of the die length of the first vibrator, and having arranged to bilateral symmetry to the first vibrator.

[0015] Furthermore, since the second vibrator works as load mass of the first vibrator and there is the second two vibrator by preparing the second vibrator in the amplitude antinode location of the both ends of the first vibrator at two symmetry, a more powerful vibration is obtained. Moreover, ellipse vibration can be excited in the direction of arbitration by arranging the second vibrator to a radial to the first vibrator. Moreover, by arranging the first vibrator and second vibrator on a right angle in the same configuration, it is easy to double the resonance frequency of two vibrator, and a powerful ellipse vibration can be excited stably.

[0016] Furthermore, vibration is insulated by fixing the above-mentioned vibrator only near the antinode location of the first vibrator. Moreover, it becomes a more powerful ellipse vibration by allotting a displacement expansion device to a resonator and one in the ellipse generating side of vibrator. Moreover, the insulation of vibration is ensured a conclusion member and by preparing a vibration isolation member between the fixed end.

[0017] Furthermore, it becomes an ultrasonic actuator by forcing a driven member on the ellipse oscillating generating location by the longitudinal oscillation of the first vibrator and the second vibrator according to a press device.

[0018]

[Example 1] It is the graph with which drawing 1 and drawing 2 show this example, drawing 1 shows drawing of longitudinal section, and drawing 2 shows the phase of high-frequency voltage. 1 is an ultrasonic vibrator and this ultrasonic vibrator 1 consists of the first vibrator 2 and the second vibrator 3. The first piezoelectric device 4 is arranged in the knot location of vertical resonance of the first vibrator 2. a piezoelectric device -- plurality -- a laminating -- carrying out -- changing -- the -- one -- a piezoelectric device -- four -- respectively -- GND -- an electrode -- a plate -- five -- a piezoelectric device -- an electrode -- a plate -- (-- G --) -- five -- the contact surface -- a confrontation -- driver voltage -- ** -- an electrode -- a plate -- (-- B --) -- six -- putting -- having -- as -- a laminating -- carrying out -- having -- the -- both ends -- a resonator -- seven -- eight -- putting -- - having -- **** -- conclusion -- a member -- nine -- one -- fixing -- having -- **** .

[0019] Moreover, in the tip antinode location of the first vibrator 2, a resonator 7 is the die length of one wave of abbreviation for the longitudinal oscillation of the second vibrator 3, and abbreviation's [the overall length L of the first vibrator 2,] is in bilateral symmetry by carrying out, and constitutes the resonator of the second vibrator 3 with the projection [like] 19. the arrangement as the piezoelectric device 4 of the first vibrator 2, and the electrode plates 5 and 6 with the second vibrator 3 same to the both ends of a resonator 7 -- it is -- piezoelectric devices 12 and 13, the GND electrode plate 14, and the electrode for driver voltages (A) -- 15 and 16 (A') are being firmly fixed to the resonator 7 by the conclusion member 18 in one with the resonator 17 arranged on the both ends. The overall length of the second vibrator 3 is twice (2L) the first vibrator 2.

[0020] Vertical resonance vibration of the second vibrator 3 is the secondary longitudinal oscillation, and the die length of a resonator 17 is decided to be the suitable die length for which piezoelectric devices 12 and 13 come to the knot location of vibration. The quality of the material of said resonators 7, 8, and 17 is formed with metals, such as good aluminum of an oscillation characteristic, duralumin, stainless steel, and brass.

[0021] more than -- a configuration -- from -- changing -- an ultrasonic vibrator -- one -- the -- two -- vibrator -- three -- ***** -- allotting -- having had -- a piezoelectric device -- an electrode -- (-- A --) -- 15 -- illustration -- an abbreviation -- having carried out -- an RF generator -- impressing -- high-frequency voltage -- a phase -- an electrode (A') -- 16 -- impressing -- having -- high-frequency voltage -- receiving -- 180 degrees -- it can shift -- impressing . By driving the second vibrator 3 with the resonance frequency of the secondary length of the second vibrator 3, the antinode location between said knots and knots vibrates greatly in the direction of longitudinal oscillation of the second vibrator 3 by two or more piezoelectric devices allotted to ***** of the second vibrator 3.

[0022] At this time, ellipse vibration is excited by the intersection parts 21 of the first vibrator 2 and the second vibrator 3 by the ability shifting the high-frequency voltage (B) impressed to the piezoelectric device 4 of the first vibrator 2 90 degrees to the above (A). And the ellipse oscillating direction is reversed by changing the phase of the high-frequency voltage impressed to (B) 180 degrees.

[0023] According to this example, the langevin type oscillator which makes in agreement the resonance frequency of two vertical resonance vibration is formed, and it becomes the ultrasonic vibrator which compounds a powerful and efficient ellipse vibration by this.

[0024] In addition, although it was made reversed in this example 180 phases of the high-frequency voltage given to the second vibrator, the direction of polarization of a piezoelectric device may be reversed, it may be in phase, and, naturally you may drive. Moreover, when [, such as in the case of the second vibrator in this example etc.,] vibrator has two or more knots, if there is even the minimum, it is obvious [the knot which puts a piezoelectric device] that ellipse vibration is compounded.

[0025]

[Example 2] The side elevation in which drawing 3 - drawing 8 show this example, and the side elevation where drawing 3 carried out the cross section of the part, the important section sectional view in which drawing 4 shows a modification, drawing 5 , and drawing 6 show a drive condition, drawing 7 , and drawing 8 are graphs which show the phase of the high-frequency voltage at the time of a drive. In this example, the same number is given to the same component as said example 1, and the explanation is omitted.

[0026] The ultrasonic vibrator 23 of this example has arranged the third vibrator 22 of the same configuration as the second vibrator 3 in parallel with the second vibrator 3 in the antinode location of the first vibrator 2 on both sides of the resonator 8 of the first vibrator 2 of the ultrasonic vibrator 1 in said example 1. A hole 28 is established in the resonator 26 of the third trembler 22 with a clearance where the flange 25 of the conclusion member 24 does not contact a resonator 26, and the depth of a hole 28 is decided to be it so that the conclusion

by the flange 25 may be near the knot location of a trembler 2 and the suitable thrust for a piezoelectric device 4 may be applied. The conclusion member 24 has a thin diameter section 29, by the female screw 31 formed in the edge 30, is a bolt 32 and is being fixed to the fixed part 33.

[0027] The ultrasonic vibrator 23 which consists of the above configuration sets to A high-frequency voltage for a drive which the piezoelectric-device terminal of second vibrator 3 upper left-hand side is given in drawing 5. Make into A' high-frequency voltage which the piezoelectric device on the right-hand side of the second vibrator 3 is given, and right-hand side is made into C' for it of the first vibrator 2 by making left-hand side of B and the third vibrator 22 to C. If the drive approach as shown in drawing 7 is taken, vibration which shakes right and left with the second and third vibrator 3 and 22 by making the core P of an ultrasonic vibrator 23 into an approximate rotational center will be excited, and longitudinal oscillation will be excited by coincidence with the first vibrator 2.

[0028] Consequently, ellipse vibration is excited at the intersection 21 of vibrator. Reversal of the phase of the electrical potential difference impressed to the first vibrator 2 180 degrees reverses the direction of ellipse vibration. Since the conclusion member 24 is fixing the first vibrator 2 near core P of the first vibrator 2 at this time, there is an operation of vibration isolation that vibration cannot get across to the conclusion member 24 easily. Moreover, if the drive approach of drawing 8 is taken, vibration carried out as shown in drawing 6 will be performed.

[0029] According to this example, vibration of a longitudinal direction increases by having attached the second vibrator 3 and the third vibrator 22 of the same configuration in the antinode location of the first vibrator 2 so much in parallel at bilateral symmetry at the first vibrator 2. Since the conclusion member 24 is fixing the first vibrator 2 near core P of the first vibrator 2 at the time of *****, there is an operation of vibration isolation that vibration cannot get across to the conclusion member 24 easily. The effectiveness increases by forming a thin diameter section 29 in the conclusion member 24.

[0030] In addition, the modification of this example is shown in drawing 4. The closing-in flange 34 is formed in the lower limit of the thin diameter section 29 of a conclusion member, and shock absorbing material 35 and a washer 36 are pinched between the bolt 32 and the fixed part 33. The quality of the material of shock absorbing material 35 is rubber, the felt, plastics, or its complex, and should just be a holddown member 33, a bolt 32, and matter with a big acoustic impedance. The increase of the vibration isolation effectiveness and effectiveness increase more by forming a flange 34 in the lower limit of the thin diameter section 29 of a conclusion member, and putting shock absorbing material 35 to between a bolt 32 and a fixed part 33.

[0031]

[Example 3] Drawing 9 and drawing 10 show this example, drawing 9 is a perspective view and drawing 10 is an explanatory view of operation. In this example, the same number is given to the same component as said each example, and the explanation is omitted. This example formed the second vibrator 3 in the direction which is in the same flat surface as the second vibrator 3 in said example 2, and intersects perpendicularly further. When putting in another way, the second four vibrator 3 was formed at equal intervals (spacing of every 90 degrees) into the same flat surface of the antinode location of the first vibrator 2 at the radial. The third vibrator 22 in said example 2 was similarly formed in the antinode location of the first vibrator 2 at four radials.

[0032] If the first and the second and third vibrator which have the axial center of each vibrator in the same flat surface when the ultrasonic vibrator 38 which consists of the above configuration sets [the axial center of the longitudinal oscillation of the first vibrator 2] it of 39, 40, and the third vibrator 22 to 41 and 42 for it of 43 and the second vibrator 3 are driven by the approach [like] in said example 2, ellipse vibration will be excited in said flat surface. In the combination of vibrator with the axial center contained at flat surfaces other than this flat surface, ellipse vibration is excited in that field.

[0033] Moreover, ellipse vibration can be excited in the flat surface of the arbitration which contains the axial center 43 of the first vibrator 2 in arbitration by exciting the vibrator of two or more of said fields with the suitable phase contrast for coincidence. Furthermore, the vibration 44 to which the whole will sway and turn only around two or more second vibrator 3 in the same flat surface if suitable phase contrast is had and driven can be excited. When the second vibrator 3 is arranged with 90 gaps like this example, between the vibrator 3 shifted 90 degrees in location, by the ability shifting the phase of drive frequency 90 degrees, it broadcasts to the appearance shown in drawing 10, and vibration is excited.

[0034] According to this example In addition to the effectiveness of said example 2, the direction of ellipse vibration can be excited in the direction of arbitration.

[0035]

[Example 4] The side elevation, drawing 12, and drawing 13 to which drawing 11 - drawing 13 showed this example to, and drawing 11 carried out the cross section of the part are the partial side elevation showing a modification. In this example, the displacement expansion device was allotted to a resonator and one in the ellipse oscillating generating side of an ultrasonic vibrator. That is, the horn 45 for amplitude expansion was formed at a resonator 7 and one on the field (this field 21 corresponds to the antinode location of the longitudinal oscillation of the first vibrator 2.) of the intersection 21 of longitudinal oscillation when the ultrasonic vibrator 23 in said example 2 intersects perpendicularly.

[0036] In this example, the longitudinal oscillation of the first vibrator 2 is expanded by having established the displacement expansion device.

[0037] According to this example, a powerful ultrasonic vibrator is constituted by expanding the longitudinal oscillation of the first vibrator.

[0038] In addition, as long as the configuration of a horn expands the longitudinal oscillation of the first vibrator 2, what kind of configuration is sufficient as it, and the horn for displacement expansion still more generally [the step horn 47 with a stage which is shown in drawing 13] used also in the mere horn 46 with a stage as shown in drawing 12 is sufficient as it.

[0039]

[Example 5] Drawing 14 is the side elevation which carried out the cross section of the part which shows this example. This example puts the piezoelectric device 63 of plurality [appearance / edges / of the resonator 62 of the shape of a cross joint of a symmetry form / four], and the resonator 64 is being fixed with the bolt 65. The conclusion member 66 is fixing the resonator 64, the piezoelectric device 63, and the resonator 62 to one so that the conclusion member 66 may not contact the core hole 67 of said resonance object 62. The female screw and the light-gage flange 69 for immobilization are prepared in the other end of the conclusion member 66, and it is fixed with the bolt 70 arranged on the fixed part 71. The die length of each resonator is decided so that said four piezoelectric devices 63 may come to the knot location of the secondary vertical resonance vibration of each vibrator.

[0040] In this example, with the same resonance frequency, a phase shifts 90 degrees and 2 sets of langevin type oscillators arranged on the cross joint drive.

[0041] According to this example, since the dimension configuration of two langevin type oscillators was made in agreement, a gap of resonance frequency cannot take place easily and composition of ellipse vibration becomes easy.

[0042]

[Example 6] The side elevation where drawing 15 and drawing 16 showed this example, and drawing 15 carried out the cross section of the part, and drawing 16 are the fragmentary sectional views showing a modification. In this example, it is the example which constituted the ultrasonic actuator by pressing a driven object to the ellipse oscillating generating side of said ultrasonic vibrator. At this example, it is what used the ultrasonic vibrator 23 of said example 2, and this ultrasonic vibrator 23 is an arrangement thing in parallel with the second vibrator 3 about the third vibrator 22 of the same configuration as the second vibrator 3 in the antinode location of the first vibrator 2 at the both sides of the resonator 8 of the first vibrator 2 of the ultrasonic vibrator 1 in said example 1.

[0043]

は、超音波振動子23の楕円振動により、被駆動体56がx方向に駆動される。この時、被駆動体56の両端に配された板バネ55により、被駆動体56とガイドレール51の平行度のズレがある場合にも、被駆動体56がy方向に移動可能で、かつ、平行板バネ55の作用により、超音波振動子23と被駆動体56の押圧条件に影響を与えない。また、平行板バネ55による振動絶縁作用もある。

【0046】本実施例によれば、簡単な構成で超音波リニアアクチュエータが実現できる。

【0047】尚、本実施例は前記実施例2の超音波振動子を用いて構成したが、本発明はこれに限定するものではなく、本発明の全ての超音波振動子を用いて実現できる。また、本実施例の超音波アクチュエータにおいて、図16に示す様に、固定部49（もしくは50）より板バネ72を固定して、その先端に押圧ローラ61が回転自在に固定され、板バネ72の中間に配されたボルト73で押圧ローラ61の押圧力をコントロールする事により、適当な押圧条件を容易に調整する事ができる。さらに、本構成の超音波アクチュエータは、リニアタイプに限らず、楕円振動発生部へ回転体を押圧する事により、回転型の超音波アクチュエータが実現できる。

【0048】

【発明の効果】以上説明した様に、本発明に係る超音波振動子および超音波アクチュエータによれば、超音波振動子の縦振動を合成して強力な可逆の楕円振動を励起す*

* することができ、効率のよい駆動を行うことができる。

【図面の簡単な説明】

【図1】実施例1を示す縦断面図である。

【図2】実施例1を示すグラフである。

【図3】実施例2を示す側面図である。

【図4】実施例2の変形例を示す要部断面図である。

【図5】実施例2の駆動状態を示す側面図である。

【図6】実施例2の駆動状態を示す側面図である。

【図7】実施例2を示すグラフである。

10 【図8】実施例2を示すグラフである。

【図9】実施例3を示す斜視図である。

【図10】実施例3を示す説明図である。

【図11】実施例4を示す側面図である。

【図12】実施例4の変形例を示す部分側面図である。

【図13】実施例4の変形例を示す部分側面図である。

【図14】実施例5を示す側面図である。

【図15】実施例6を示す側面図である。

【図16】実施例6の変形例を示す部分断面図である。

【図17】従来例を示す側面図である。

20 【符号の説明】

1 超音波振動子

2 第一振動子

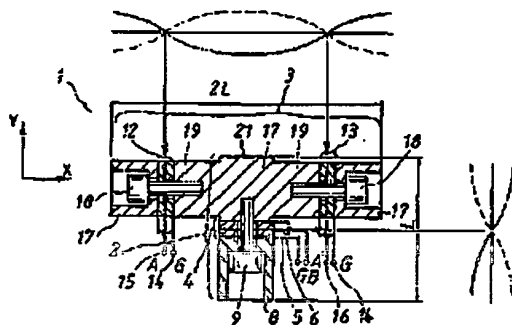
3 第二振動子

4、12、13 圧電素子

7、8、17 共振器

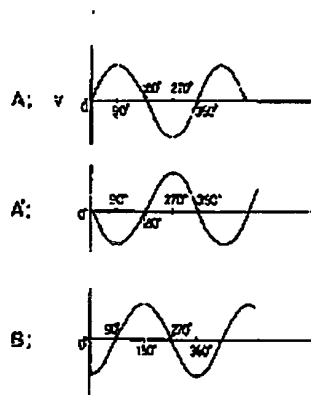
9、18 締結部材

【図1】



- 1 超音波振動子
- 2 第一振動子
- 3 第二振動子
- 4、12、13 圧電素子
- 7、8、17 共振器
- 9、18 締結部材

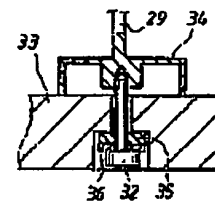
【図2】



【図12】



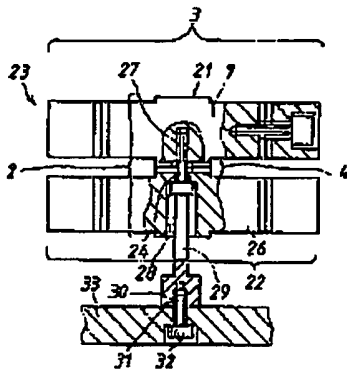
【図4】



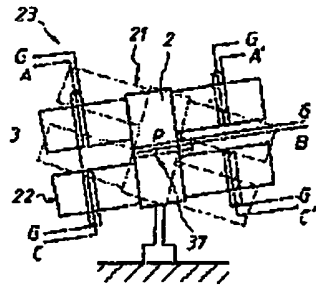
【図10】



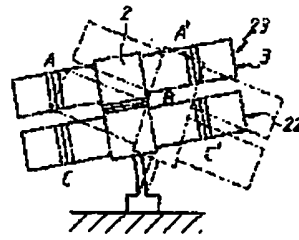
【図3】



【図5】



【図6】

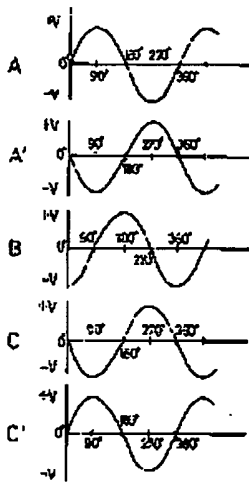


【図13】

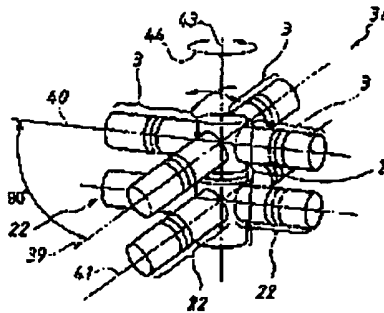
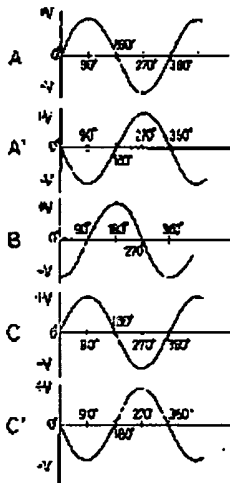
【図9】



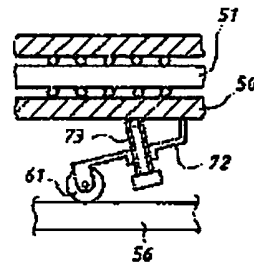
【図7】



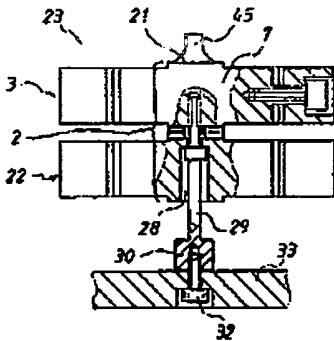
【図8】



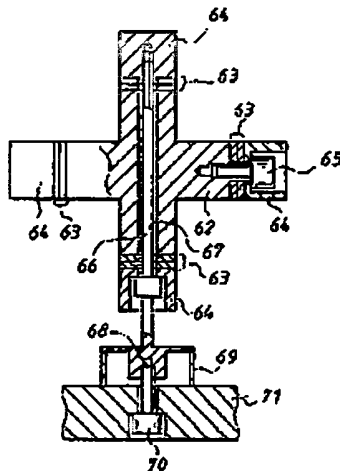
【図16】



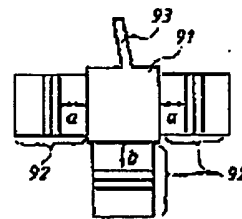
【図11】



【図14】



【図17】



【図15】

